Title: Where Is the Treasure?

Link to Outcomes:

- **Problem Solving**   Students will demonstrate their ability to solve mathematical problems with various strategies in cooperative groups using tools of technology.

- **Cooperation**   Students will demonstrate their ability to solve problems cooperatively.

- **Communication**   Students will demonstrate their ability to communicate mathematical concepts using appropriate language and symbolism.

- **Technology**   Students will demonstrate their ability to use *The Geometer's Sketchpad*™ and TI-81/82 graphics calculator.

- **Measurement**   Students will demonstrate their ability to use *The Geometer's Sketchpad*™ to measure the lengths of segments.

- **Algebra**   Students will demonstrate their ability to use and solve systems of equations, slope-intercept of a line, and ratios and proportions.

- **Reasoning**   Students will synthesize previous learning and reason logically to determine the solution.

- **Geometry**   Students will demonstrate their ability to apply geometric concepts to the solution of a real world problem.

- **Connections**   Students will show the relationship of mathematics to history and geography. Students will integrate algebraic concepts into a geometric problem.

Brief Overview:

In cooperative groups students will investigate the solution of the problem — finding the buried treasure — by various strategies including use of the Pythagorean Theorem, similar triangles, linear systems, and coordinate geometry. All students will eventually explore the problem using *The Geometer's Sketchpad*™.

Grade/Level:

Grades 9 – 12, Geometry/Algebra I (end of course)/Algebra II as a review

Prerequisite Knowledge:

- Cooperative group processes
- Pythagorean Theorem
- Similar triangles
- Linear systems
- Coordinate geometry
- Distance formula
- Slope
- Use of *The Geometer's Sketchpad*™
- Use of TI-81/82 graphics calculator

Objectives:

- Students will work cooperatively to discover the solution of a real world problem by one of several strategies.
- Students will use *The Geometer's Sketchpad*™ to verify group solutions to problem.

Materials/Resources/Printed Materials:

- Activity 9 worksheet from NCTM Addenda Series/Grades 9-12 "Connecting Mathematics"
- TI-81/82
- Graph paper (quadrille)/pencil/ruler
- Overhead projector and transparencies
- *The Geometer's Sketchpad*™ and computers

Development/Procedures:

Day 1/2

Lesson will be introduced with the following type of warm-up activity:
1. Teacher will give a system of linear equations to use for review . Students will analyze the meaning of the solution. (What does "x" mean? What does "y" mean?)
2. Teacher will give a problem using the Pythagorean Theorem to find a leg given the hypotenuse and the other leg.
3. Teacher will give a slope-intercept form of an equation. (What does the constant represent?)
4. Teacher will give a key. Students will find dimensions of a triangle to scale (e.g. 1 inch = 60 feet).

Students will work in their groups to find the buried treasure using data on worksheet by the method of their choice. Students may need graph paper. Upon completion of the problem each group will present their solution to the class using transparencies and an overhead projector. Teacher should insure that each student participates in the presentation. Each student is responsible for a written report with diagrams detailing the group's solution.

Day 2/3

Students will use *The Geometer's Sketchpad*™ to justify their solution. They will construct a diagram to scale, measure the length of the line segment, find appropriate ratios, and verify their solution.

Evaluation:

- Group/individual participation and completion of worksheet will be monitored by the teacher.

- Each member will participate in one phase of the group oral presentation of the solution of the problem.

- Each student will prepare a written report of the group's solution.

- Teacher will use the rubric included to assess each student's achievement on the oral and written presentations.

Extension/Follow Up:

Have students develop an original problem with map and solution to challenge others in the class to find the buried treasure. Encourage use of *The Geometer's Sketchpad*™.

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Notes To Teacher

There are many approaches to solving this problem. Students may wish to:

- Use the Pythagorean Theorem to find the distance from A to B and from C to D.

    $\overline{AB} = 180$
    $\overline{CD} = 100$

- Place the figure on a rectangular coordinate system so that A is at the origin and the road from A to D is along the x-axis.

- Find the slopes of line segments BD and AC

    Slope of $\overline{BD} = \frac{3}{4}$
    Slope of $\overline{AC} = \frac{5}{12}$

- Find the y-intercepts of lines BD and AC.

    y–intercept of $\overline{BD}$ is 180
    y–intercept of $\overline{AC}$ is 0

- Find the equation of lines BD and AC.

    equation of $\overline{BD}$ is $y = -\frac{3}{4}x + 180$
   *equation of $\overline{AC}$ is $y = \frac{5}{12}x$*

- Solve this system of equations to find the point of intersection.

    point of intersection $(\frac{1080}{7}, \frac{450}{7})$

- Use similar triangles to solve the problem.

- Use *The Geometer's Sketchpad*™. The use of *The Geometer's Sketchpad*™ eliminates the use of algebra from the solution. It fosters the use of scale factors, eye-hand coordination and complete understanduing of the problem and its relation to geometry.

WHERE IS THE TREASURE?

You are on a trip to one of the Cartesian Islands. In the cellar of your cabin you have found an old map that claims to hold the secret location of a buried treasure. The map shows four trees at locations A, B, C, and D. The trees at A and D are along a road that runs through the island. The tree at B is directly north of the tree at A, and the tree at C is **directly** north of the tree at D.
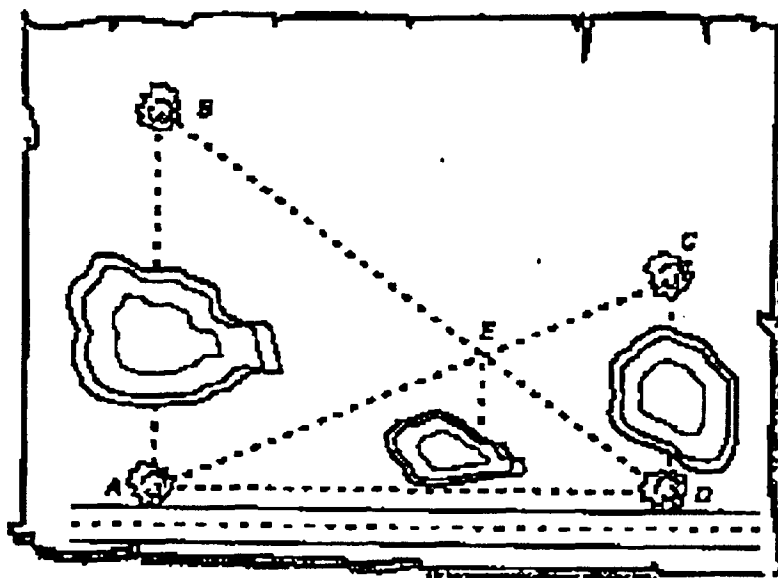
The map's directions say to trace a path from the tree at B to the tree at D, and to do the same for the trees at A and C. The treasure is buried halfway between the intersection of these paths and the road. Because three small lakes dot the island, you are only able to measure the distances between B and D, A and C, and A and D:

<div align="center">

B to D   300 paces

A to C 260 paces

A to D 240 paces

</div>

To find the location of the treasure, you must determine the distance from E to the road and then walk half that distance from E. How far is E from the road?

REFERENCE

Froelich, Gary W., et al. *Connecting Mathematics..* Curriculum and Evaluation Standards for School Mathematics Addenda Series, Grades 9-12. Reston, Va.: National Council of Teachers of Mathematics, 1992. (Activity 9 p.56)

Directions for use of *The Geometer's Sketchpad*

1. Draw line segment of any length (it is now selected).
2. Label endpoints A and D.
3. Use ⌘-M to find midpoint and label H.
4. Select midpoint H and endpoint D.
5. Use ⌘-L to find the segment.
6. Use ⌘-M to find the midpoint. Label the midpoint G.

Note: From G to D represents 1 unit.

7. Select endpoint A as the center by double clicking.
8. Hold shift and select G.
9. Rotate 90°.
10. Draw a segment. Label the endpoint B.
11. Select endpoint D as the center by double clicking.
12. Hold shift and select midpoint G.
13. Rotate -90°.
14. Dilate to 1.66.
15. Construct a segment by holding ⌘-L. Label the endpoint C.
16. Construct segments AC and BD.
17. Select segments AC and BD. Construct the point of intersection. Label the point of intersection E.
18. Select point E and segment AD. Construct the perpendicular.
19. Construct the point of intersection of the perpendicular and segment AD. Label F.
20. Now hide the perpendicular.
21. Construct the segment from E to F.
22. Measure segments AD and EF.

Segment AB is in scale to 180.
Segment EF is how long?

$$\frac{\overline{AB}}{180} = \frac{\overline{EF}}{x}$$
$$x = 180\frac{\overline{EF}}{\overline{AB}}$$

Use calculate.

Location of the treasusre is at the midpoint of segment EF. Therefore the treasure is located 31.30 paces from point E on the segment EF. Use calculate to determine this distance.

Calculate the slopes of the segments AC and BD using *The Geometer's Sketchpad*™.

WHERE IS THE TREASURE?

You want to create the map on your assignment sheet using the display, construction and measure tools of *The Geometer's Sketchpad*™. The directions are as follows:

1.   Change your measure to pixels.
   - DISPLAY — go down and choose Preferences
   - Distance Units
   - down to PIXELS — click OK

2.   Position points A and D on your screen.
   - CONSTRUCT AD
   - MEASURE AD until it is 240 pixels
     (Drag D while watching the measurement until you get 240.)

3.   Create point B above point A.
   - CONSTRUCT B at A by:
   - Select and A and AD
   - CONSTRUCT perpendicular
   - LABEL top point B

4.   CONSTRUCT BD
   - MEASURE BD until it is 300 pixels
     Drag B down while watching the measurement until you get 300

5.   Create point C above point D
   - REPEAT STEPS 3 FOR POINTS C & D substituting C for B and D for A
   - CONSTRUCT AC
   - MEASURE AC until it is 260 pixels
     Drag C down while watching the measurement until you get 260

6.   Select segments BD and AC
   - CONSTRUCT point at intersection — label E

7.   Select E and AD
   - CONSTRUCT perpendicular

8.   Select perpendicular and AD
   - CONSTRUCT point of intersection — label F
   - Select E and F
   - CONSTRUCT segment
   - Select perpendicular line
   - DISPLAY hide line

10.   Select EF — Measure

11.   Select EF
   - CONSTRUCT midpoint – your MIDPOINT is your TREASURE!!!

EVALUATION SHEET

NAME _____

	1	2	3	4
ORAL PRESENTATION				
WRITTEN PRESENTATION				
Neatness				
Clarity of Explanation				
Diagram				
Accuracy/Content				